

(19) World Intellectual Property
Organization
International Bureau



(43) International Publication Date
2 December 2004 (02.12.2004)

PCT

(10) International Publication Number
WO 2004/103613 A1

(51) International Patent Classification⁷: B22F 3/00,
5/10, B23B 51/00

(21) International Application Number:
PCT/SE2004/000768

(22) International Filing Date: 18 May 2004 (18.05.2004)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
0301456-0 20 May 2003 (20.05.2003) SE

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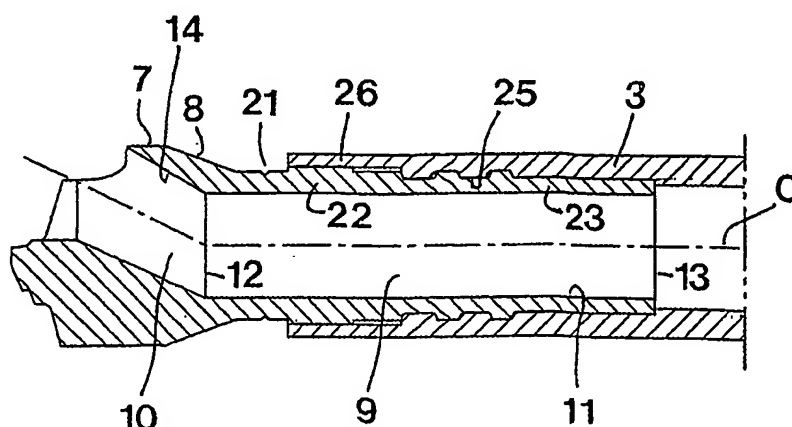
(81) Designated States (unless otherwise indicated, for every
kind of national protection available): AE, AG, AL, AM,
AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN,
CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI,
GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE,
KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD,
MG, MK, MN, MW, MX, MZ, NA, NI, NO, NZ, OM, PG,
PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SY, TJ, TM,
TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM,
ZW.

(84) Designated States (unless otherwise indicated, for every
kind of regional protection available): ARIPO (BW, GH,
GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM,
ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM),
European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI,
FR, GB, GR, HU, IE, IT, LU, MC, NL, PL, PT, RO, SE, SI,
SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ,
GW, ML, MR, NE, SN, TD, TG).

Published:
— with international search report

For two-letter codes and other abbreviations, refer to the "Guid-
ance Notes on Codes and Abbreviations" appearing at the begin-
ning of each regular issue of the PCT Gazette.

(54) Title: AN EDGE-CARRYING DRILL BODY, AND A METHOD FOR THE MANUFACTURE OF THE SAME AND A
DRILLING TOOL COMPRISING SUCH A DRILL BODY



(57) Abstract: In a first aspect, the invention relates to an edge carrying drill body (1) of the type that is intended for deep hole drilling, and which is rotatable around a geometric axis (C) as well as comprises a through channel (2) arranged for internal chip evacuation, which channel mouths in front and rear ends of the body. Characteristic of the invention is that one or more cutting edges (4) are made integrally with the rest of the body, more precisely from a hard material, such as cemented carbide or CERMET. In a second aspect, the invention also relates to a method for the manufacture of such a drill body. In a third aspect, the invention furthermore relates to a drilling tool for deep hole-drilling.

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AN EDGE-CARRYING DRILL BODY, AND A METHOD FOR THE MANUFACTURE
OF THE SAME AND A DRILLING TOOL COMPRISING SUCH A DRILL BODY

Technical Field of the Invention

5 In a first aspect, this invention relates to an edge-carrying drill body, which is rotatable around a central geometric axis and comprises a through channel arranged for internal chip evacuation, which channel mouths in front and rear ends of the body.

10 In a second aspect, the invention relates to a method for the manufacture of edge-carrying drill bodies of the above-mentioned type.

In a third aspect, the invention also relates to a drilling tool, which includes an edge-carrying drill body of
15 the kind in question.

Description of the Prior Art

Within the field of chip forming machining, deep hole drilling constitutes an area difficult to master, in particular
20 when the holes should be extraordinary long or deep. By long holes, holes having a relatively great ratio of hole depth to hole diameter are normally intended. Usually, it is about hole depths of from $5 \times D$ up to $100 \times D$ or more. For the machining in question, drilling tools of two different main categories
25 are usually used, viz. so-called ejector drills and STS drills (Single Tube System), respectively, the last-mentioned one of which includes a front drill body and at least one tube extending backwards from the same with which tube the drill body is detachably connected. In the last-mentioned case, supply of the
30 cutting fluid requisite for lubrication and cooling takes place on the outside of the tube, while the chip evacuation as well as the evacuation of the cutting fluid takes place internally via a through channel in the drill body and the interior of the tube. The drilling is usually carried out in special deep hole
35 drilling machines that are constructed for optional operation method, e.g., rotary workpiece, rotary tool or a combination of both rotary workpiece and rotary tool. However, most common is that the workpiece rotates, while the tool solely guarantees

the linear feed motion. Furthermore, it should be pointed out that drilling by means of STS drills may be carried out either by full drilling (when the hole is drilled in a solid material to a predetermined diameter in one single operation) or such as boring (cf. also reaming and broaching).

Generally, the drill bodies of deep hole drills are made from a basic body of steel or the like, as well as one or more cutting inserts of cemented carbide or CERMET, the cutting inserts including the cutting edge(s) that is(are) required for the chip removal. In coarser drills, viz. for hole diameters > 25 mm, the cutting inserts may be fastened on the basic body either by being soldered onto the same, or be detachably connected to the basic body, e.g., by means of screws. In the last-mentioned case, the cutting inserts usually consist of indexable inserts. However, at small diameters (9-25 mm), only soldered cutting inserts are possible because the requisite means for clamping detachable cutting inserts would complicate and weaken the comparatively weak steel body too much. In both cases, however, not only the drill bodies as such, but also the manufacture of the same, are associated with a plurality of disadvantages. Thus, an aggravating disadvantage from the point of view of manufacturing technology is that the production cost becomes very high, in particular for drills having a small diameter. A disadvantage performance-wise of the drill bodies as such is that the same have to be made with asymmetrical tool geometry where the drill tip is displaced or eccentric in relation to the geometrical centre axis of the drill body. In order to, in this connection, carry the radial cutting forces, the drill body has to, on the outside thereof, be provided with at least two strips, which have the purpose of supporting and guiding the drill body during the drilling operation. The existence of said supporting and guiding strips may give rise to pressing-in of chips and particles in the machined hole surface and give rise to extreme generation of heat by the friction contact thereof with the hole surface. Furthermore, the strips intrude on the width of the chip inlet(s); something that in turn increases the risk of chip stopping and inferior chip breaking. Another disadvantage of the previously known drilling

tools is that the same may be totally destroyed if the drill body would get stuck in a workpiece, more precisely so far that not only the front drill body but also the tube being behind are demolished upon jamming. It should also be pointed out that the precision of the drill bodies during machining may become mediocre, in particular after one or more exchanges of cutting inserts.

Objects and Features of the Invention

10 The present invention aims at obviating the above-mentioned disadvantages of previously known drilling tools for deep hole drilling and at providing an improved drilling tool. Therefore, in a first aspect, it is a primary object of the invention to provide an edge-carrying drill body, which can be
15 series produced in a simple way to low costs, more precisely by eliminating the need for complementary mounting of separate cutting inserts. An additional object is to provide a drill body, the chip inlets of which to the through chip evacuation channel can be constructed with optimum width with the purpose
20 of improving the chip breaking and counteracting the risk of chip stopping. Yet an object of the invention is to provide a drill body that reduces the risk of total damage if the drill body would get stuck in a workpiece. Furthermore, it is an object to provide a drill body that can be made having different, desirable properties in different parts of the same. Yet
25 an object of the invention is to provide opportunities for the manufacture of self-centring drill bodies in which the need for annoying supporting and guiding strips has been eliminated. It is also an object to provide a drill body that guarantees a
30 good machining precision and that has a long service life. An additional object of the invention is to provide a drill body, which during chip removal generates chips of a reduced width in order to facilitate the chip evacuation.

 According to the invention, at least the primary
35 object is attained by means of the features defined in the characterizing clause of claim 1. Preferred embodiments of the drill body according to the invention are furthermore defined in the dependent claims 2-15.

In addition to the drill body as such, the invention also relates to a method for the manufacture of drill bodies of the kind in question. The features of this method is seen in the independent claim 16. Preferred embodiments of the method according to the invention are further defined in the dependent claims 17 and 18.

In a third aspect, the invention also relates to a drilling tool for deep hole drilling. The features of the same drill tool are seen in the independent claim 19.

10

Summary of the Invention

The invention is based on the intention to manufacture drill bodies for deep hole drilling, i.e. drill bodies having an internal, through chip and cooling liquid channel, in one single piece in which one or more edges are integrated, the body in its entirety being made from the same fundamental type of material which is used in separate cutting inserts, in particular cemented carbide and CERMET, respectively. In this way, the drill body in its entirety can be made in one single lift in a suitable injection moulding machine, each need for complementary mounting of separate cutting inserts being eliminated. The manufacture may advantageously be carried out in accordance with the method defined in claim 18.

25 Further Elucidation of Prior Art

By, for instance, PCT/SE 00/02073, PCT/SE 02/01814, PCT/SE 02/01916 and PCT/SE 02/02060, it is previously known to manufacture detachable machining bodies, so-called loose tops, which are made with one or more edges integrally with a basic body of cemented carbide and fastenable on a front end of a long narrow shaft. However, in this case, the machining body as well as the shaft lack every form of internal chip channel through which chips and cooling liquid may be evacuated internally in the way which is required in the present invention.

35

Brief Description of the Appended drawings

In the drawings:

- Fig 1 is a perspective view regarded obliquely from the front of a first, single-edged embodiment of a drill body according to the invention,
- Fig 2 is a somewhat diminished front view of the same drill body,
- Fig 3 is a first side view of the drill body regarded from the right in fig 2,
- Fig 4 is a second side view regarded from the left in fig 2,
- Fig 5 is a planar view from above in fig 2,
- Fig 6 is an enlarged longitudinal section through the same drill body mounted in a tube, which together with the drill body form an operative drilling tool,
- Fig 7 is a schematic longitudinal section through a moulding tool for the manufacture of the drill body according to figs 1-6.
- Fig 8 is a perspective view of a drill body made with two cutting edges according to an alternative embodiment,
- Fig 9 is a front view of the drill body according to fig 8,
- Fig 10 is a perspective view of a third alternative embodiment according to which the drill body is made with three cutting edges, and
- Fig 11 is a front view of the drill body according to fig 10.

Detailed Description of Preferred Embodiments of the Invention

In figs 1-5, a first embodiment is shown of an edge-carrying drill body 1, which is rotatable around a central geometric axis C and comprises a through channel arranged for internal chip evacuation, generally designated 2. Said channel mouths in front and rear ends of the body 1.

The drill body 1 is connectable with a cylindrical tube 3 shown in fig 6, together with which tube the same forms an operative drilling tool of the type that, by those skilled in the art, is denominated STS drill (Single Tube System). Drills of this type are intended for deep hole drilling and are included in an extensive drilling equipment, which in the area of the rear end (not shown) of the tube 3 includes sealing devices via which cooling liquid can be introduced under pressure in the ring-shaped gap that is formed between the outside

of the tube and a hole recessed by the drill body 1 in a work-piece. For this purpose, the tube 3 has an outer diameter that is smaller than the diameter of the recessed hole. Evacuation of the cooling liquid as well as the chips released by the
5 drill body is carried out internally via the channel 2.

In the example shown, the drill body 1 includes a single cutting edge generally designated 4. In accordance with the invention, said cutting edge 4 is made integrally with the rest of the drill body, the body in its entirety being manufac-
10 tured from a hard, wear-resistant material. In practice, the drill body is suitably manufactured from cemented carbide or CERMET, although also other materials having great hardness are feasible on condition that the hardness is considerably greater than the hardness of steel or the like. The technique to manu-
15 facture the drill body will be described more in detail below, reference being made to fig 7.

The drill body 1 comprises a front head 5, which carries the cutting edge 4, as well as a thinner, hollow shaft or sleeve 6. The head 5 has a cylindrical or rotationally symmet-
20 rical basic shape so far that the same has a cylindrical or slightly conical envelope surface 7. Via a marked conical surface 8, the envelope surface 7 transforms into the shaft 6, which has a cylindrical or rotationally symmetrical basic shape.

The through chip channel, in its entirety designated
25 2, includes two different sections or bores 9, 10, the first-mentioned one of which is cylindrical and concentric with the centre axis C. More precisely, the internal cylinder surface 11, which defines the bore 9, is entirely smooth from the front end 12 thereof to the rear opening 13. The front bore 10, which
30 forms an inlet for the chips, extends generally at an obtuse angle to the bore 9. The interior surface 14 that defines the chip inlet 10 has a partially conical and partially planar shape, more precisely in such a way that the inlet widens in
35 the forward direction or outwards. Thus, the inlet is substantially funnel-like. Via two brake lines 15, 16, the inlet transforms into two planar surfaces 17, 18, which extend at an obtuse angle to each other.

The front surface 19 of the head 5 has a generally conical shape so far that the surface in question converges from the periphery in the direction of the centre of the drill body. The cutting edge 4 is formed in the transition between the planar surface 17 and the front surface 19, the surface 17 forming a cutting surface and the cone surface 19 a clearance surface. Although the cutting edge 4, per se, could consist of an edge that is entirely straight from the centre to the periphery, it has, in the embodiment shown, been preferred to form the edge in steps. More precisely, the cutting edge is formed with three different part edges 4a, 4b, 4c, the part edge 4a of which positioned closest the centre is situated somewhat in front of the next following part edge 4b, etc. On the side of the centre axis of the drill body which is opposite the front part edge 4a, a secondary part edge 4d is also formed, which belong to the part edge 4a so far that said part edges together form a front tip. By the fact that the cutting edge 4 in this way is composed of a plurality of different part edges, displaced axially in relation to each other, a plurality of different chips will be separated in the drilling which separately is thinner than the total length of the cutting edge. In this way, chip breaking as well as chip evacuation is, to a large extent, facilitated.

Because the drill body 1 in this case includes only one cutting edge 4, at least two strips 20 are required in order to support and guide the drill body during operation. These strips 20 are formed on the outside of the drill head and are tangentially spaced. More precisely, one of the strips or the guiding strip is located at a point approximately in linear extension of the cutting edge 4, while the second strip or the supporting strip is displaced at an arc angle of approx. 90° in relation to the guiding strip.

The tubular piece of material that forms the shaft 6 includes a relatively thick, front wall section 22, as well as a thinner, rear wall section 23.

In order to connect the drill body 1 with the tube 3, these components are formed with connection means. In the example, said connection means consist of threads. More precisely,

a male thread 24 is formed on the shaft 6 of the drill body, while a female thread 25 is formed on the inside of the tube 3. In this connection, it should be pointed out that the front wall section 26 of the tube 3 is somewhat thinner than the rest of the tube wall. Characteristic of the male thread 29 is that the chaser along tangentially spaced areas on the shaft is interrupted, while providing planar, chaser-free surfaces or formations. More precisely, said chaser-free formations are located on diametrically opposed sides of the shaft, the individual part chaser becoming substantially semi-circular and being defined at opposite ends by wedge-shapedly tapering, substantially planar surfaces 27. The female thread 25 is, however, made in the form of a whole, continuous chaser. In this connection, it should be pointed out that the tube 3 is made from steel or the like, which can be machined by turning. Thus, the female thread 25 may be provided by conventional chasing of threads.

By forming flattened surfaces 27 in the above described way on opposite sides of the shaft, form stripping of an initially formed green ware of the type that will be described below is made possible.

In the drill body 1, a breakage weakening is included, which in the example is in the form of a circumferential groove 21 in the envelope surface of the shaft 6. This groove is advantageously circular and located in a plane that extends perpendicularly to the centre axis C. The groove is located between the transition surface 8 of the head 5 and the male thread 24 on the shaft. More precisely, the groove is located comparatively near the transition surface 8, whereby the same will be located in front of the front end of the tube 3 when the drill body is applied in the tube. By the existence of said breakage weakening 21, the drill body may be divided into two parts if the head would get stuck in a workpiece. The tube 3 together with the separated, rear part of the drill body can, on that occasion, proceed to rotate without being demolished. If the groove extends perpendicularly to the centre axis C, rotation of the tube (which at the rear end thereof is clamped in the drive mechanism of the drilling equipment) can

be effected without axial forces being applied to the tube via the site of breakage. In this connection, it should, however, be pointed out that the groove or the breakage weakening also may be formed in such a way that the rotation of the drill tube is stopped. Thus, the groove may be inclined in relation to the centre axis or be made curved or arched in order to, upon jamming of the drill body, apply an axial impulsive force to the drill tube, which stops the drive mechanism of the drilling equipment.

Manufacture of the Drill Body According to the Invention

In order to explain the preferred method according to which the described drill body is series produced, reference is made to fig 7, which illustrates a moulding tool especially constructed for the purpose, which is mountable in an injection moulding machine (not shown). In this tool, two blocks 28, 29 are included, which are spaced-apart via an interface 30. The block 28 is fixedly mounted in the machine, while the block 29 is movable backwards and forwards in relation to the block 28.

In the fixed block 28, three mould parts 31, 32, 33 are included, which together define a tool cavity designated 34. The mould part 31 is fixed in the block 28, while the two mould parts 32, 33 are spring-activated and movable to and fro the mould part 31. More precisely, the mould parts 32, 33 are partially wedge-shaped in order to be pressed inwards towards each other to the position shown in fig 7 when the movable block 29 is pressed inwards towards the fixed block 28. However, when the block 29 is distanced from the block 28, the two mould parts 32, 33 are brought, by a number of springs (not visible), to be distanced not only from the mould part 31, but also mutually (the mould part 32 moves in the direction obliquely up towards the left in fig 7, while the mould part 33 moves obliquely down towards the left). In the cavity 34, two core pullers or male plugs 35, 36 may be inserted, which at free ends thereof are formed so that they can be inter-connected in a common connection point 42. On the outside of the male plug 35, which is in the form of a cylindrical bar, a likewise cylindrical ejector tube 43 is arranged. The cylindrical male

plug 35 has the purpose of forming a vacant space in the cavity 34 with the aim of providing the bore 9 in the completed drill body 1. The second, oblique male plug 36 is partially conical and has the purpose of forming the chip inlet 10 in the completed drill body. In the cavity 34, an inlet 44 mouths, which co-operates with a needle valve 45 by means of which the inlet may be opened and shut in order to batch-wise feed in a mouldable, semi-plastic material compound from a store included in the machine via a feeding opening 46. Opening and closing of the needle valve 45 is guaranteed by a gear mechanism generally designated 47.

The shape of the internal part surfaces of the mould parts 31, 32, 33 which define the tool cavity 34 corresponds to the external shape of the drill body 1 to be made.

The compound which is injected in the cavity 34 contains a mixture of hard, cutting material-forming particles as well as a provisional, degradable adhesive. This provisional adhesive may in practice consist of a combination of different plastics and waxes, which can be stripped away by extraction followed by thermal evaporation or solely thermal evaporation. The concept "cutting material" such as this is used in the present description and the subsequent claims should primarily be regarded to include cemented carbide and CERMET. Conventional cemented carbide is a powder metallurgical material, which essentially is built up by a number of carbides in at least one binder metal. The carbides that are of use are all very hard and may consist of primarily wolfram carbide (WC), but also titanium carbide (TiC), tantalum carbide (TaC) and niobium carbide (NbC), while the binder metal usually consists of cobalt (Co) or cobalt alloys. CERMET is, in turn, a common denomination on powder metallurgical material in which the hard particles consist of titanium carbide (TiC), titanium carbon nitride (TiCN) and/or titanium nitride (TiN). Characteristic of CERMET is that ceramic particles are also included in the binder metal, which for instance may consist of cobalt or nickel-cobalt.

The manufacture is carried out in the following way:

- 5 a) In a first step, the moulding tool is closed by the movable block 29 being pressed inwards towards the fixed block 28 to the position shown in fig 7. In this connection, the two movable mould parts 32, 33 are brought together in the direction of the male plug 35 at the same time as they are pressed against the fixed mould part 31 so as to establish the tool cavity 34. In conjunction hereby, also the male plugs 35, 36 are inserted into the tool cavity and are connected together in the connection point 42. In this state, 10 the tool is ready for injection of the compound, wherein the internal surfaces of the mould parts will decide the external shape of the body to be made, while the internal shape of the bores 9, 10 is determined by the male plugs 35, 36,
- 15 b) In the next step, the compound is injected in the cavity 34 via the inlet 44. When the cavity has been filled with compound, a certain holding pressure is maintained during a suitable time in order to guarantee that the compound is stabilized and absolutely completely fills out the entire 20 cavity. In this connection, a green ware is formed, the shape of which corresponds to the shape of the cavity and the male plugs.
- 25 c) In a third step, the formed green ware is form stripped by the measures to retract the male plug 36, as well as distance the movable block 29 from the fixed block 28. In this connection, the two movable mould parts 32, 33 will on one hand be distanced from the fixed mould part 31, and on the other hand be distanced from each other and from the central male plug 35. The moulded green ware remains on that 30 occasion in an exposed state on the free end portion of the male plug 33. In order to remove the green ware from the male plug 35, the ejector tube 43 is projected out in the direction of the free end of the male plug.
- 35 d) When the green ware has been released, the adhesive is stripped away from the body. This takes place by extraction followed by thermal evaporation or solely by thermal evaporation. When the adhesive has been stripped away, only the particles that are to form the final cutting material

remain in the green ware. Either before or after this treatment, the riser which is formed in the inlet 44 may be removed from the front surface (the surface 19 on the completed drill body) of the green ware.

- 5 e) In a final step, the green ware treated in this way is sintered by heating to at least 1 300 °C while obtaining a hardened drill body having the final shape and dimension. In connection with the sintering, the green ware shrinks linearly by 17 to 20 % of the original dimensions thereof
10 determined by the tool cavity 34.

Above, it has been described how a single homogeneous compound is injected in the moulding tool. The described manufacturing method opens, however, also possibilities for making
15 the drill body from two or more material compounds having different properties. For instance, those material sections in which the cutting edge and the envelope surface of the head, respectively, are included, could be made from a material having greater hardness and resistance to wear than the material
20 in other sections in the body. In practice, such multi-stage injection moulding may be effected by one or more additional male plugs in addition to the two above-described being inserted in the tool cavity and being drawn out one by one when a first basic body has been formed in the cavity. These supplementing male plugs then leave hollow spaces, which in one or
25 more later steps may be filled with powder compounds that give material having other properties than the material in the basic body. In this case, naturally one or more additional injection inlets are also required together with the appurtenant chambers
30 for different powder compounds.

Brief Description of Additional Embodiments of the Drill Body According to the Invention

In figs 8 and 9, an alternative embodiment is visual-
35 ised according to which the drill body 1 is formed with two cutting edges 4, which are formed in a bridge designated 37, which bridges over the through front opening of the channel 2. As is seen in fig 9, two chip inlets 10 are defined on opposite

sides of said bridge 37, which are located in the area in front of the appurtenant cutting edges 4 seen in the direction of rotation of the drill. The two edges 4 are generally diametrically opposed each other and mutually parallel, although displaced out of plane in relation to the geometrical centre axis of the drill body. In this connection, the inner ends of the edges are inter-connected via an inclined chisel edge 38, which in a conventional way may be formed with a centre punch (not shown), which forms a centring tip in connection with the entering of the drill in a workpiece. Contrary to the asymmetrical, single-edged drill body according to figs 1-5, the drill body shown in figs 8 and 9 has a generally symmetrical geometry, more precisely so far that the two cutting edges are equidistantly separated (180°) in the tangential direction. This symmetrical geometry means that the cutting forces on the two edges balance out each other so that the drill becomes self-centring. For this reason, the head 5 of the drill body may be formed with an envelope surface 7, which is genuinely rotationally symmetrical and smooth in so far that the same lacks protruding supporting and guiding strips. However, in this connection, it should be pointed out that a suitable number of tangentially spaced, countersunk flutes may be formed in the envelope surface, which extend axially between the front and rear ends of the envelope surface and have the purpose of facilitating feed of cooling and lubrication liquid to the cutting edge.

In figs 10 and 11, a third embodiment is illustrated according to which a bridge 37 bridging over the chip channel opening is formed with three integrated cutting edges 9. Thus, in this case, the bridge includes three bars or bar-like material portions 39, which emanate from a central intermediate portion of a ring-shaped wall 40 in which three countersinks are formed, which form chip inlets 10 to the internal, through chip channel. The surface 14 defining each individual chip inlet 10 (see also the surface 14 in fig 8) is partially cone-shaped in order to facilitate the transportation of the chips into and through the inlet. The three bars together with the appurtenant edges are mutually equidistantly spaced-apart in the tangential direction, i.e. the separation between the same

is 120°, the edges converging in a common point that forms a centring tip 91 located along the geometrical centre axis of the drill body.

5 In the example according to fig 10, straight cutting edges 4 are shown. However, these could, - like the cutting edges 4 according to fig 8 - also be stair-shaped in order to produce part chips having a reduced width.

Advantages of the Invention

10 Within the range of deep hole drilling, the invention opens entirely new possibilities of efficient, cost efficient recession of deep holes in connection with full drilling as well as in connection with boring (and reaming and broaching, respectively). In particular, the invention enables recession
15 of long holes having a limited diameter, e.g., diameters less than 15 mm, while guaranteeing an extremely good precision. One reason for this is that the drill body can be produced in one single piece without the need of time-consuming and precision-deteriorating complementary mounting of separate cutting
20 inserts (irrespective of these being soldered or consisting of clamped indexable inserts). Another substantial advantage is that the invention makes it possible to manufacture self-centring drill bodies for deep hole drilling. This has previously not been possible in such drill bodies intended for deep hole
25 drilling that make use of soldered cutting inserts or indexable inserts. A particular advantage in connection with self-centring drill bodies of the type that do not require supporting and/or guiding on the outside thereof is that the chip inlets may be formed with increased width, resulting in improved
30 transportation of chips and reduced risk of chip stopping. Furthermore, by the existence of the particular breakage weakening (which can be made by the simple measure of giving the mould parts a suitable design), the advantage is gained that the risk of total damage of the entire drill tool is reduced to a mini-
35 mum.

Feasible Modifications of the Invention

The invention is not solely limited to the embodiments described above and shown in the drawings. Thus, instead of a threaded joint, other types of connection means may be used, e.g., bayonet couplings, in order to detachably connect the drill body with the tube of the drill. It is also possible to connect the drill body with the tube in another way, e.g., by soldering or the like. In this connection, it should also be pointed out that the drill tube may be composed of a plurality of tube sections in extension of each other. Furthermore, it should be pointed out that the cutting geometry of the drill body such as this primarily is determined by the shape and location of the cutting edges on the head of the drill body may vary most considerably within the scope of the subsequent claims. The drawings that have been used in order to illustrate the general idea according to the invention do not, accordingly, relate to any finished products and should only be regarded as principle drawings (which are influenced by preliminary prototypes of the final products). It should also be mentioned that the described breakage weakening may be realized in another way than in the form of a continuous groove in the envelope surface of the shaft. Furthermore, it should be pointed out that the drill body also may be made from other cutting materials than the ones mentioned above, e.g. ceramics. Also, the different part edges of the individual cutting edge may be step-like displaced in relation to each other in another way than stair-shaped. For instance, the midmost part edge of three part edges may be countersunk (or raised) in relation to the two surrounding ones. Thus, the essential thing is that the different part edges are located on different levels in order to generate chips the width of which is smaller than the total width of the cutting edge.

List of References

- 1 = drill body
- 2 = chip channel
- 5 3 = drill tube
- 4 = cutting edge
- 5 = drill body head
- 6 = drill body shaft
- 7 = envelope surface on head
- 10 8 = transition surface
- 9 = main bore in chip channel
- 10 = chip inlets
- 11 = limiting surface of main bore
- 12 = bore end
- 15 13 = bore opening
- 14 = limiting surface of chip inlets
- 15 = break line
- 16 = break line
- 17 = front surface
- 20 18 = limiting surface
- 19 = front surface
- 20 = supporting and guiding strips
- 21 = breakage weakening
- 22 = front shaft section
- 25 23 = rear shaft section
- 24 = male thread
- 25 = male thread
- 26 = front tube section
- 27 = flattened chaser section
- 30 28 = fixed moulding tool block
- 29 = movable moulding tool block
- 30 = interface between block
- 31 = fixed moulding part
- 32 = movable moulding part
- 35 33 = movable moulding part
- 34 = tool cavity
- 35 = first male plug
- 36 = second male plug

- 37 = bridge
- 38 = chisel edge
- 39 = bars
- 40 = ring wall
- 5 41 = tip
- 42 = connection point
- 43 = ejector tube
- 44 = compound inlet
- 45 = needle valve
- 10 46 = feeding opening
- 47 = control mechanism

Claims

1. Edge-carrying drill body (1), which is rotatable around a central geometric axis (C) and comprises a through channel (2) arranged for internal chip evacuation, which channel mouths in front and rear ends of the body, characterized in that one or more cutting edges (4) are made integrally with the rest of the body (1).
2. Drill body according to claim 1, characterized in that the same is made by injection of a cutting material-forming compound in a cavity (34) in a moulding tool while providing a green ware, as well as hardening of the green ware by sintering.
3. Drill body according to any one of the preceding claims, characterized in that the same comprises a front, edge-carrying head (5), as well as a thinner, hollow shaft (6), which is insertable into and connectable with a tube (3) in order to, together with the same, form a drilling tool for deep hole drilling.
4. Drill body according to claim 3, characterized in that the same is detachably connectable with the tube (3) via a connection means that includes a thread (24) on the shaft (6).
5. Drill body according to claim 4, characterized in that the thread consists of a male thread (24) on the outside of the shaft (6).
6. Drill body according to claims 2 and 5, characterized in that the chaser of the thread (24) along tangentially spaced areas on the shaft (6) is interrupted while forming planar, chaser-free formations (27) with the purpose of facilitating removal of individual mould parts from the green ware.

7. Drill body according to any one of claims 3-6, characterized in that the same includes a breakage weakening (21) with the purpose of separating the head and the shaft in the event the head would be stuck in a workpiece.

5

8. Drill body according to claim 7, characterized in that the breakage weakening consists of a peripheral groove (21) formed in the shaft.

10 9. Drill body according to any one of the preceding claims, characterized in that the same includes one single cutting edge (4), which extends from a tip to the periphery of the drill body, and that the through channel (2) includes an axially oriented, rear bore (9), which is concentric with the
15 centre axis (C), as well as a front bore (10) serving as chip inlet, which bore extends in extension of and at an obtuse angle to the rear bore, on the outside of the drill body at least two strips (20) being formed that are tangentially spaced from each other and from the cutting edge.

20

10. Drill body according to claim 9, characterized in that the chip inlet (10) is funnel-shaped and converges in the direction inwards/backwards towards the rear bore (9).

25 11. Drill body according to any one of claims 1-8, characterized in that a front mouth to the through channel (2) is bridged over by a bridge (37) in which a plurality of edges (4) are included, which extend from a common, centring tip to the periphery of the drill body and which are located after a
30 respective chip inlet (10) seen in the direction of rotation of the drill body.

12. Drill body according to claim 11, characterized in that the bridge (37) comprises three edges (4) that are
35 separated 120° and converge into a common point that forms a centring tip (41).

13. Drill body according to claim 11, c h a r a c t e r i z e d in that the bridge (37) comprises two edges (4) that are parallel to each other, although displaced out of plane in relation to the centre axis (C), inner ends of the edges being interconnected via an inclined chisel edge (38) having a punch,
5 which forms a centring tip.

14. Drill body according to any one of claims 11-13, c h a r a c t e r i z e d in that the head (5) of the drill body has an envelope surface (7) that is generally rotationally symmetrical and smooth so far that the same lacks protruding supporting
10 strips.

15. Drill body according to any one of the preceding claims, c h a r a c t e r i z e d in that the individual cutting edge (4) is formed with a plurality of step-like displaced part edges (4a, 4b, 4c) having the purpose of generating part chips, the width of which is smaller than the total length of the
15 edge.

20

16. Method for the manufacture of an edge-carrying drill body (1) of the type that is rotatable around a central, geometric axis (C) and that comprises a through channel (2) arranged for internal chip evacuation, which channel mouths in front and
25 rear ends of the drill body, c h a r a c t e r i z e d in that one or more cutting edges (4) are made integrally with the rest of the drill body (1).

17. Method according to claim 16, c h a r a c t e r i z e d by
30 the steps of

- a) into a cavity (34) in a collapsible moulding tool, inserting at least two male plugs (35, 36), which together with internal surfaces of mould parts (31, 32, 33) decide the shape of the cavity,
- 35 b) into the cavity (34), injecting a compound containing a mixture of hard, cutting material-forming particles as well as an adhesive, while forming a green ware the shape of which corresponds to the shape of the cavity,

- c) form stripping the green ware by, on one hand, distancing the mould parts (31, 32, 33) from the green ware, and on the other hand removing the male plugs (35, 36), a first male plug (35) leaving a vacant space, which forms a rear bore (9) in the green ware being concentric with the centre axis (C), while a second male plug (36) leaves a front chip inlet (10) in the same,
- d) by extraction and heat treatment or solely heat treatment, stripping away the adhesive from the green ware while leaving only cutting material-forming particles in the same, and
- e) sintering the green ware treated in this way by heating to at least 1300 °C while receiving a hardened drill body (1) having the final shape and dimension.

18. Method according to claim 17, characterized in that one or more additional male plugs are inserted into the tool cavity (34), which plugs after injection of a first material compound are drawn out of the cavity in order to form one or more hollow spaces in which material compounds having other properties than the first material compound may be injected before form stripping of the green ware.

19. Drilling tool for deep hole drilling, comprising a tube (3) and a drill body (1) detachably connected with the same, characterized in that the drill body consists of a drill body according to any one of claims 1-15.

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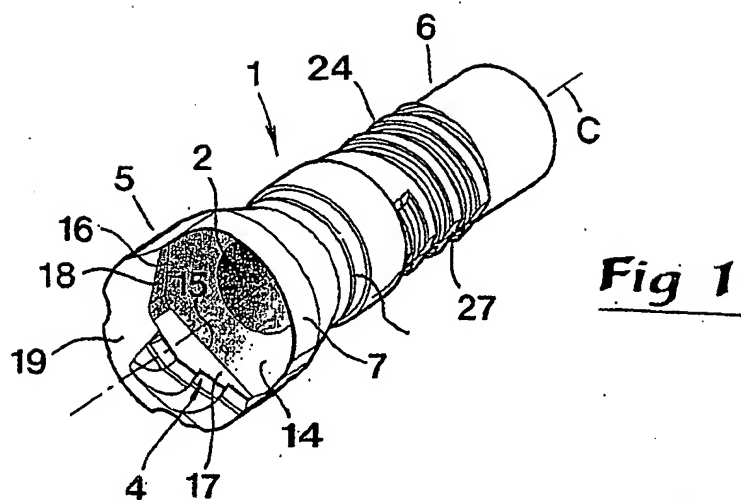


Fig 1

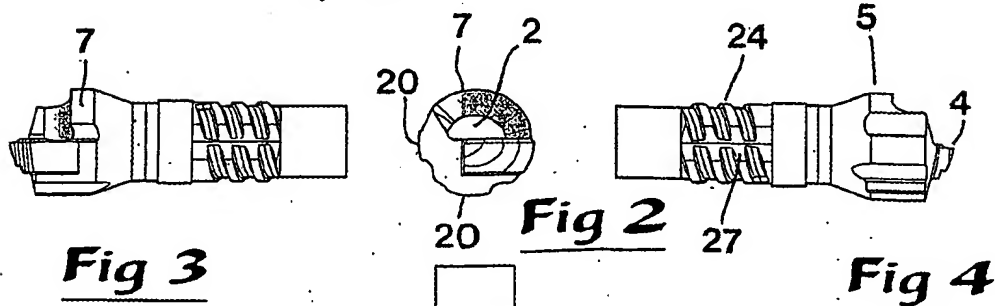


Fig 3

Fig 2

Fig 4

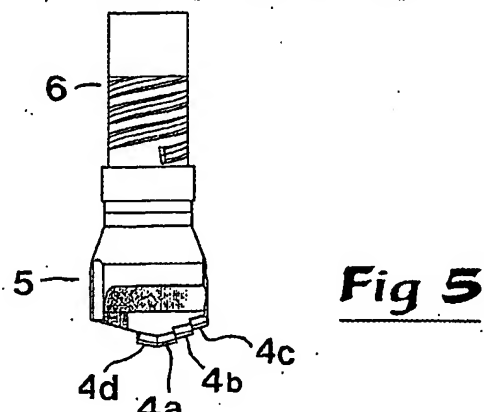


Fig 5

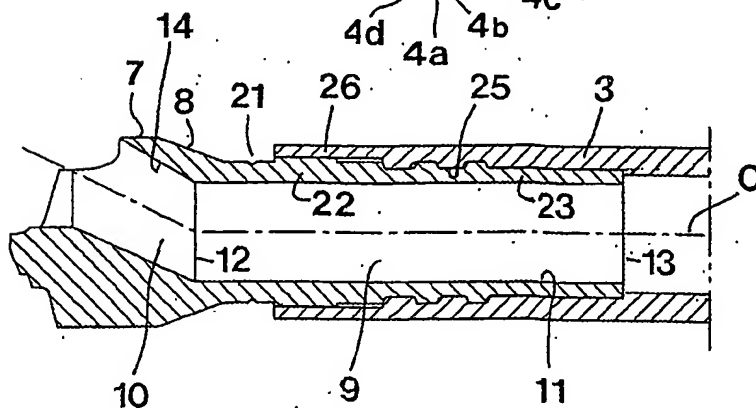
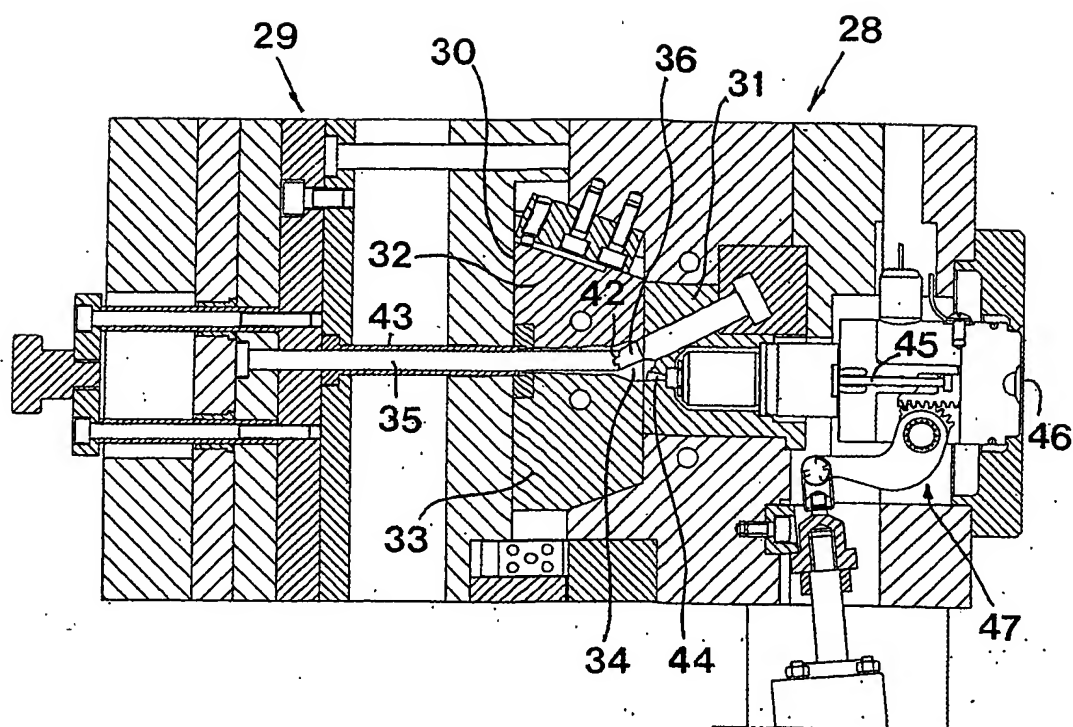


Fig 6

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**Fig 7**

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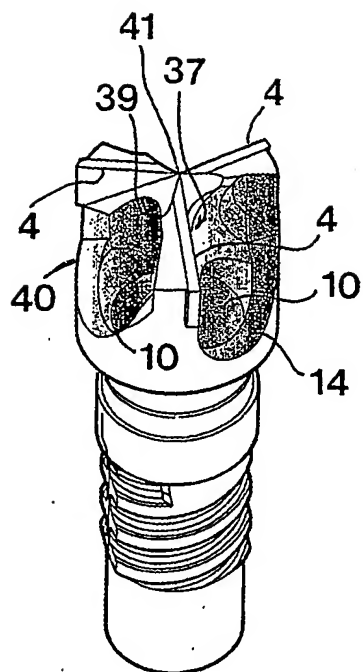


Fig 10

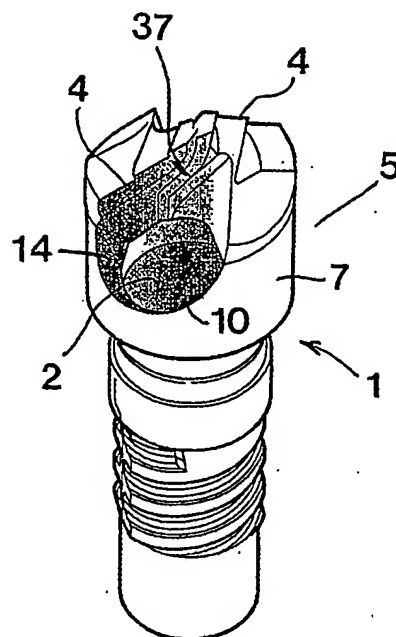


Fig 8

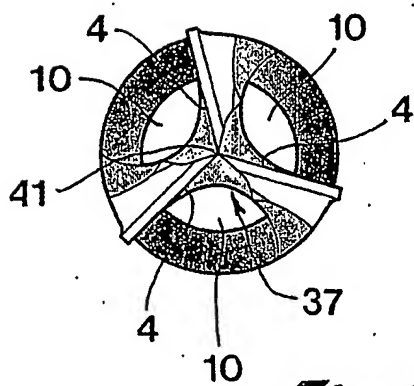


Fig 11

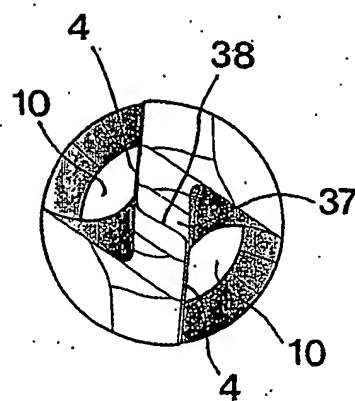


Fig 9

INTERNATIONAL SEARCH REPORT

International application No.

PCT/SE 2004/000768

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: B22F 3/00, B22F 5/10, B23B 51/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: B22F, B23B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-INTERNAL, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 6551035 B1 (JOHNNY BRUHN ET AL), 22 April 2003 (22.04.2003), column 2, line 1 - line 52; column 3, line 50 - column 4, line 7; column 6, line 32 - column 7, line 54, figures 12-15	1,2,16-18,19
Y	--	3-15
X	US 5863162 A (RONNY KARLSSON ET AL), 26 January 1999 (26.01.1999), column 2, line 39 - line 62	1,2,16-18,19
Y	--	3-15

☒ Further documents are listed in the continuation of Box C.☒ See patent family annex.

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"O" document referring to an oral disclosure, use, exhibition or other means

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"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

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"&" document member of the same patent family

Date of the actual completion of the international search

13 Sept 2004

Date of mailing of the international search report

14 -09- 2004

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/SE 2004/000768

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	SE 509383 C2 (SANDVIK AB), 18 January 1999 (18.01.1999)	3-8
A	--	1-2, 9-15, 16-18, 19
Y	WO 0198008 A1 (SANDVIK AKTIEBOLAG), 27 December 2001 (27.12.2001)	3-8
A	--	1, 2, 9-15, 16-18, 19
Y	US 5851094 A (BENGT STRAND ET AL), 22 December 1998 (22.12.1998)	3-8
A	--	1, 2, 9-15, 16-18, 19
A	WO 0143899 A1 (TDY INDUSTRIES, INC.), 21 June 2001 (21.06.2001)	1-19
A	RU 2156180 C2 (OTKRYTOE AKTSIONERNOE OBSHCHESTVO "PODOL'SKIY MASHINOSTROITEL' NYJ ZAVOD"), 20 Sept 2000 (20.09.2000)	1-19
	-- -----	

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INTERNATIONAL SEARCH REPORT

Information on patent family members

31/07/2004

International application No.

PCT/SE 2004/000768

US	6551035	B1	22/04/2003	CN	1379704	T	13/11/2002
				EP	1222047	A	17/07/2002
				JP	2003511253	T	25/03/2003
				SE	9903685	A	15/04/2001
				US	6716388	B	06/04/2004
				US	2003118413	A	26/06/2003
				WO	0126856	A	19/04/2001
<hr/>							
US	5863162	A	26/01/1999	CN	1077473	B	09/01/2002
				CN	1235568	A	17/11/1999
				DE	69713790	D,T	20/02/2003
				EP	0935508	A,B	18/08/1999
				JP	2001503683	T	21/03/2001
				KR	2000053040	A	25/08/2000
				SE	510533	C	31/05/1999
				SE	9604039	A	05/05/1998
				WO	9819813	A	14/05/1998
<hr/>							
SE	509383	C2	18/01/1999	AT	189785	T	15/03/2000
				AU	683394	B	06/11/1997
				AU	2756695	A	05/01/1996
				BR	9508000	A	18/11/1997
				CA	2192580	A	21/12/1995
				CN	1059851	B	27/12/2000
				CN	1152269	A	18/06/1997
				DE	69515117	D,T	09/11/2000
				EP	0765202	A,B	02/04/1997
				SE	0765202	T3	
				JP	10501184	T	03/02/1998
				PL	178302	B	28/04/2000
				PL	317661	A	28/04/1997
				RU	2135331	C	27/08/1999
				SE	9402037	A	14/12/1995
				US	5964553	A	12/10/1999
				WO	9534398	A	21/12/1995
<hr/>							
WO	0198008	A1	27/12/2001	AU	1653501	A	04/06/2001
				AU	7471401	A	02/01/2002
				CA	2396342	A	31/05/2001
				CN	1437519	T	20/08/2003
				EP	1232394	A	21/08/2002
				EP	1292417	A	19/03/2003
				JP	2003515171	T	22/04/2003
				JP	2003535705	T	02/12/2003
				SE	518390	C	01/10/2002
				SE	0002294	A	21/12/2001
				US	2003170084	A	11/09/2003

INTERNATIONAL SEARCH REPORT

Information on patent family members

31/07/2004

International application No.

PCT/SE 2004/000768

US	5851094	A	22/12/1998	BR	9713833	A	29/02/2000
				CN	1087985	B	24/07/2002
				CN	1239449	A	22/12/1999
				DE	69715654	D,T	28/05/2003
				EP	0942798	A,B	22/09/1999
				EP	1224994	A	24/07/2002
				HK	1023741	A	00/00/0000
				JP	2001505136	T	17/04/2001
				KR	2000057362	A	15/09/2000
				SE	510628	C	07/06/1999
				SE	9604445	A	04/06/1998
				WO	9824579	A	11/06/1998
<hr/>							
WO	0143899	A1	21/06/2001	AU	1959401	A	25/06/2001
				CN	1423586	T	11/06/2003
				EP	1244531	A	02/10/2002
				HU	0203598	A	28/02/2003
				IL	150068	D	00/00/0000
				JP	2003516867	T	20/05/2003
				PL	355375	A	19/04/2004
				US	6511265	B	28/01/2003
<hr/>							
RU	2156180	C2	20/09/2000	NONE			
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